What is claimed is:

1. A subsystem for a cable modem termination apparatus to allow flexible upstream and downstream mapping, comprising:

a downstream mapper having one or more inputs for coupling to DOCSIS downstream transmitters, and one or more outputs for coupling to hybrid fiber coaxial cable systems, and having a control input;

an upstream mapper having one or more inputs for coupling to hybrid fiber coaxial cable systems and having one or more outputs for coupling to inputs of one or more DOCSIS upstream receivers, and having a control input;

a control circuit coupled to said control inputs for generating signals which control which transmitters are coupled to which optical nodes and which optical nodes are coupled to which receivers.

2. The apparatus of claim 1 wherein said control circuit is a computer programmed with at least one upstream media access control process (UMAC) and a downstream media access control process (DMAC) for each DOCSIS downstream generated by one of said transmitters, and wherein said computer is programmed by said UMAC and DMAC processes to exchange data between said UMAC process and said DMAC processes to allow a flexible number of downstreams share the same upstream receiver.

3. The apparatus of claim 1 further comprising a cable modem termination system comprising:

a storage/cache circuit;

one or more downstream transmitter line cards, each having a DOCSIS downstream transmitter thereon which is coupled to said downstream mapper;

a timestamp counter means coupled to said transmitter line cards for providing synchronized timestamp counts to all transmitter line cards which are sharing an upstream receiver line card;

one or more upstream receiver line cards, each having a DOCSIS upstream receiver thereon having an radio frequency input coupled to said upstream mapper;

a forwarder/application server;

a packet switch having one or more ports for coupling to a wide area network, one or more ports for coupling to one or more local content servers, one or

more ports coupled to said storage/cache circuit, one or more ports coupled to said transmitter line cards, one or more ports coupled to said receiver line cards, one or more ports coupled to said forwarder/application server;

and wherein each said receiver is a separate line card which has a computer therein programmed with an upstream media access control process (UMAC);

and each said transmitter is a separate line card having a computer therein programmed to execute a downstream media access control process (DMAC) for a DOCSIS downstream generated by said transmitter;

and wherein at least one of said receivers represents a shared upstream receiver shared by a plurality of downstreams;

and wherein said computers in said line cards are programmed by said UMAC process of said shared upstream receiver and said DMAC processes of said transmitters which share said shared upstream receiver to exchange data between said UMAC process and said DMAC processes via said packet switch to allow a flexible number of downstreams to share the same upstream receiver.

4. The apparatus of claim 3 wherein said UMAC process monitors traffic load conditions and/or communication difficulties of cable modems tuned to downstreams that are sharing the upstream receiver on the line card which is executing said UMAC process and which are coupled to optical nodes in the HFC system, and decides if another upstream needs to be added having a lower throughput for cable modems that are having difficulty communicating upstream, and/or decides if the mapping of optical nodes to receiver line cards needs to be changed for load balancing purposes, and wherein said computer programmed with said UMAC process executing on the receiver line card which is being shared by a group of downstream transmitter lines cards then cooperates with the DMAC processes in the group of downstream transmitter line cards which are sharing the same upstream receiver to send any messages needed to create a new upstream and controls said upstream mapper to alter a mapping of optical nodes to upstream receivers to carry out load balancing or guide signals of a new lower throughput upstream to a different upstream receiver.

5. A subsystem for a cable modem termination apparatus to allow flexible upstream and downstream mapping, comprising:

a downstream mapper means having inputs for coupling to the outputs of a plurality of DOCSIS transmitters of a cable modem termination system and having outputs for coupling to a plurality of optical nodes of a hybrid fiber coaxial cable system, and having a control input, for flexibly mapping signal paths from the outputs of each of said one or more said transmitters to one or more of said optical nodes in accordance with switching control signals received at said control input;

an upstream mapper means having a plurality of inputs for coupling to a plurality of optical nodes of a hybrid fiber coaxial cable system, and having one or more outputs for coupling to the radio frequency inputs of one or more DOCSIS upstream receivers, and having a control input, for flexibly mapping signal paths from said one or more optical nodes to one or more radio frequency inputs of said one or more DOCSIS upstream receivers in accordance with switching control signals received at said control input; and

one or more computer means coupled to said control inputs of said downstream mapper means and said upstream mapper means, said computer means for generating said switching control signals for each of said downstream and upstream mapper means to implement a desired mapping of DOCSIS downstreams generated by said transmitters to said optical nodes and a desired mapping of signals from said one or more optical nodes to the radio frequency inputs of said one or more DOCSIS upstream receivers and to be able to alter said mappings easily by changing said switching control signals.

6. The apparatus of claim 5 further comprising a cable modem termination means having one or more downstream transmitter line cards each containing a DOCSIS transmitter having an output coupled to said downstream mapper means, and a timestamp counter means for supplying synchronized timestamp counts to every downstream transmitter line card in a group of downstreams which will share an upstream, and having one or more upstream receiver line cards each having a DOCSIS upstream receiver having a radio frequency input coupled to said upstream mapper mean, said cable modem termination means including a switch fabric means for routing packets between said line cards, a storage/cache circuit, a forwarder/application circuit and ports for coupling to a wide area network and local content servers, said cable modem termination means for serving as the

headend of a hybrid fiber coaxial cable system coupled via one or more optical nodes to a plurality of cable modems and for:

1) creating DOCSIS downstreams and upstreams;

2) implementing a flexible mapping between said downstreams and said optical nodes;

3) mapping one or more downstreams to a shared upstream receiver and generating and sending suitable downstream DOCSIS messages to implement said mapping;

4) implementing a flexible mapping of optical nodes to upstream receivers;

5) carrying out load balancing and communication parameter monitoring so as to create new upstreams and downstreams with channel parameters and burst profiles as needed to meet load balancing considerations or resolve problems some cable modems may be having in communicating with said cable modem termination means.

7. The apparatus of claim 5 further comprising a cable modem termination system having one or more downstream transmitter line cards each containing a DOCSIS transmitter having an output coupled to said downstream mapper means, and a timestamp counter means for supplying synchronized timestamp counts to every downstream transmitter line card in a group of downstreams which will share an upstream, and wherein each downstream transmitter line card includes a computer or state machine programmed or structured to implement a downstream media access control (DMAC) process, and having one or more upstream receiver line cards each having a DOCSIS upstream receiver having a radio frequency input coupled to said upstream mapper mean, and wherein each upstream receiver line card includes a computer or state machine programmed or structured to implement an upstream media access control (UMAC) process, said cable modem termination system including a switch fabric coupled to and serving to route packets between said line cards, a storage/cache circuit, a forwarder/application circuit and ports for coupling to a wide area network and local content servers, said cable modem termination system functioning to serve as the headend of a hybrid fiber coaxial cable system coupled via one or more optical nodes to a plurality of cable modems, and wherein said UMAC and DMAC processes, said DOCSIS transmitters and receivers and said switch fabric and said upstream and downstream mapper means cooperate to implement the following functions:

1) creating DOCSIS downstreams and upstreams;

2) implementing a flexible mapping between said downstreams and said optical nodes;

3) mapping one or more downstreams to a shared upstream receiver, and generating and sending suitable downstream DOCSIS messages to implement said mapping;

4) implementing a flexible mapping of optical nodes to upstream receivers;

5) carrying out load balancing so as to create new upstreams and downstreams with channel parameters and burst profiles as needed to meet load balancing considerations;

6) generating and sending suitable switch control commands to said upstream and/or downstream mappers as needed to change said upstream and/or downstream mappings as needed, and generating and sending suitable DOCSIS downstream messages to cause selected cable modems to switch to said new upstreams and/or downstreams as needed to meet said load balancing considerations.

8. The process of claim 7 wherein step 5 further comprises also detecting conditions which may be causing problems in cable modems communicating with said cable modem termination system and creating new upstreams and/or downstreams with channel parameters and burst profiles as needed to resolve problems some cable modems may be having in communicating with said cable modem termination system, and wherein step 6 further comprises generating and sending suitable switch control commands to said upstream and/or downstream mappers as needed to change said upstream and/or downstream mappings as needed to resolve problems some cable modems may be having in communicating with said cable modem termination system, and generating and sending suitable DOCSIS downstream messages to cause selected cable modems to switch to said new upstreams and/or downstreams as needed to to resolve problems some cable modems may be having in communicating with said cable modem termination system.

9. A process implemented by a cable modem termination system having a plurality of downstream transmitter line cards and a one or more upstream receiver line cards, said downstream transmitter line cards coupled to a plurality of cable modems through a plurality of optical nodes and a downstream mapper, said upstream receiver line cards, said upstream receiver line cards coupled to a plurality of cable modems through a plurality of optical nodes and an upstream mapper, comprising:A process implemented by a cable

modem termination system having a plurality of downstream transmitter line cards and a one or more upstream receiver line cards, said downstream transmitter line cards coupled to a plurality of cable modems through a plurality of optical nodes and a downstream mapper, said upstream receiver line cards, said upstream receiver line cards coupled to a plurality of cable modems through a plurality of optical nodes and an upstream mapper, comprising:

1) creating DOCSIS downstreams and upstreams;

2) implementing a flexible mapping between said downstreams and said optical nodes so as to couple each DOCSIS downstream to one or more selected optical nodes via said downstream mapper;

3) mapping one or more downstreams to a shared upstream receiver and generating and sending suitable downstream DOCSIS messages to implement said mapping;

4) implementing a flexible mapping of optical nodes to upstream receivers via said upstream mapper;

5) conducting DOCSIS ranging with said cable modems and using information in said ranging bursts to build a routing table;

5) carrying out load balance monitoring so as to create new upstreams and/or downstreams with channel parameters and burst profiles as needed to meet load balancing considerations; and

6) generating and sending suitable switch control commands to said upstream and/or downstream mappers as needed to change said upstream and/or downstream mappings between receivers and said optical nodes and between transmitters and said optical nodes as needed to meet said load balancing considerations, and generating and sending suitable DOCSIS downstream messages to cause selected cable modems to switch to said new upstreams and/or downstreams as needed and to alter which downstream share an upstream so to meet said load balancing considerations.

10. The process of claim 9 wherein step 5 further comprises also detecting conditions which may be causing problems in cable modems communicating with said cable modem termination system and creating new upstreams and/or downstreams with channel parameters and burst profiles as needed to resolve problems some cable modems may be having in communicating with said cable modem termination system, and wherein step 6 further comprises generating and sending suitable switch control commands to said

upstream and/or downstream mappers as needed to change said upstream and/or downstream mappings as needed to resolve problems some cable modems may be having in communicating with said cable modem termination system, and generating and sending suitable DOCSIS downstream messages to cause selected cable modems to switch to said new upstreams and/or downstreams as needed to to resolve problems some cable modems may be having in communicating with said cable modem termination system.

11. The process of claim 10 wherein said detecting of conditions step is performed during initial ranging of each cable modem.

12. The process of claim 10 wherein said detecting of conditions step is performed during initial ranging of each cable modem and also after each cable modem has registered with said cable modem termination system, and wherein said steps of creating new upstream and/or downstreams and generating suitable switch control commands and generating and sending suitable DOCSIS downstream messages are performed whenever conditions are detected indicating a cable modem may be having problems communicating with said cable modem termination system.

13. A process carried out in a cable modem termination system (CMTS), comprising the steps:

1) determining the number and type of DOCSIS downstreams needed for cable modems (CMs) present in a hybrid fiber coaxial (HFC) cable system;

2) in a plurality of downstream line card transmitters that are to share an upstream line card receiver, obtaining synchronized timestamp counts and synchronizing a symbol clock in each downstream line card transmitter that is to share an upstream line card receiver with a master symbol clock of said upstream line card receiver;

3) mapping each downstream line card transmitters to one or more particular optical nodes in said HFC system and generating suitable switch control signals for a downstream mapper to cause said downstream mapper to couple each said downstream line card transmitter output to the one or more optical nodes to which it has been mapped;

4) transmitting one of more DOCSIS downstreams of the type and number determined in step 1 to said optical nodes in accordance with the mapping determined in step 3, and transmitting DOCSIS sync messages containing timestamp samples on each DOCSIS downstream;

5) determing which said DOCSIS downstreams are to share a DOCSIS upstream and generating in an upstream media access control process (UMAC) channel parameter and burst parameter data which defines said upstream to be shared, and controlling a switch to route said data to one or more downstream media access control (DMAC) processes for said DOCSIS downstreams to share said upstream (hereafter the downstream group);

6) generating switch control signals to control an upstream mapper to couple selected ones of said optical nodes which receive said downstream group to a radio frequency input of an upstream line card receiver representing said shared upstream;

7) using said channel parameter and burst parameter data received from said UMAC process for said shared upstream in each of the DMAC processes for downstreams mapped to share said upstream to generate and send on each downstream mapped to said said upstream upstream channel descriptor messages describing channel and burst parameters of said shared upstream;

8) determining the initial ranging contention interval in said UMAC for the shared upstream and transmitting MAP data to said DMAC processes for said downstream group (the DMAC group);

9) generating in said DMAC group MAP messages and sending said messages on said downstream group;

10) processing in said UMAC and said upstream receiver line card representing said shared upstream initial ranging bursts from said cable modems tuned to said downstream group, said processing carried out in conventional DOCSIS fashion to make timing, frequency and power offset measurements and develop upstream equalization coefficients for each cable modem;

11) sending said offset measurements and upstream equalization coefficients for each cable modem to the DMAC process for the downstream to which said cable modem is tuned, and using said data in said DMAC process to send a ranging response message to said cable modem to cause it to adjust its timing, frequency and

power and upstream equalization coefficients for subsequent upstream transmissions;

12) using data in said initial ranging bursts to build a routing table which indicates which cable modems are tuned to each downstream in said downstream group;

13) determining which cable modems still need to do more ranging, and generating in said UMAC process MAP data defining intervals during which each such cable modem may transmit additional ranging bursts and sending said MAP data to a DMAC process for a downstream to which said cable modem is tuned;

14) completing DOCSIS ranging using invited ranging bursts and registering each cable modem which has successfully completed ranging;

15) receiving upstream bandwidth requests from cable modems which have registered;

16) UMAC of shared upstream processes upstream bandwidth requests so as to grant synchronous code division multiple access (SCDMA) bursts from cable modems coupled to the same optical node so as to be grouped together during the same time interval, and so as to coordinate grants for time division multiple access (TDMA) bursts from cable modems coupled to different optical nodes coupled to said shared upstream receiver line card so that there will be no overlap in time upon arrival of said time division multiple access bursts at said receiver, and generating grant data defining these grants, and sending said grant data to DMAC processes for downstreams to which cable modems having grants are tuned;

17) generating and sending from said DMAC processes which receive grant data in step 16 MAP messages which inform cable modems having grants when they may transmit and what types of bursts they may transmit;

18) determing from said grant data and said routing table when each granted burst is expected to arrive from each cable modem and generating switch control data to control said upstream mapper so as to couple an upstream signal path from each said optical node which receives a downstream in said downstream group to said radio frequency input of said upstream receiver line card only during a time when a TDMA burst is arriving from an optical node or only during an interval when a plurality of SCDMA bursts are arriving from an optical node so as to avoid noise aggregation;

19) monitoring upstream and downstream traffic loads and deciding whether to add another upstream and/or another upstream receiver to the existing shared upstream and/or another downstream and change said upstream and/or downstream mappings; and

20) if a decision is made to add another upstream with its own identification code, suitable channel and burst parameter data is generated to define the new upstream and send to the DMACs in the downstream group, and the DMACs use this data to generate and send UCD messages which define the new upstream and to send upstream channel change messages to cable modems to be switched to said new upstream;

21) generating new switch control commands for said upstream mapper to change the mapping of optical nodes to upstream receiver line cards to implement said new upstream;

22) if a decision is made in step 19 to add another receiver to the existing upstream, generating suitable switch control signals for said upstream mapper to divert selected bursts to said new upstream receiver line card and sending any configuration data needed by said new receiver line card to configure it to receive the type of bursts to be diverted to it;

23) if a decision is made in step 19 to add another downstream, creating a new downstream and sending DOCSIS channel change messages to cable modems to be switched to said new downstream, and generating suitable switch control signals to said downstream mapper to change mapping between said downstream line card transmitters and said optical nodes; and

24) re-initializing any cable modems switched to new downstreams and/or upstream per conventional DOCSIS processing.

14. The process of claim 13 further comprising the steps of monitoring one or more characteristics of said initial ranging bursts from each cable modem which are indicative of whether said cable modem is having or would be likely to have trouble communicating with said CMTS in future transmissions, and if said characteristics are such as to indicate present or possible future trouble in communicating upstream with said CMTS, creating a new upstream having channel parameters and a burst profile which would be likely to allow each said cable modem which is having trouble communicating upstream to communicate

effectively upstream with said CMTS and moving said cable modems which are having problems or which are likely to have future problems communicating with said CMTS to said new upstream.

15. The process of claim 13 further comprising the steps of:

A) determining which cable modems (CMs) are having problems or would be likely to have problems in the future with reliable upstream communication with said CMTS by monitoring a communication parameter of initial ranging bursts from each cable modem;

B) generating data that defines a lower throughput upstream channel and sending said data to the DMACs for downstreams to which are tuned CMs located in step A;

C) using said data generated in step B in said DMAC processes for downstreams to which CMs located in step A are tuned to generate new UCD messages which define channel and burst parameters of a new lower throughput upstream, and sending said UCD messages downstream;

D) generating channel change messages in said UMAC of an upstream shared by said downstream group, and sending said channel change messages to said DMACs coupled to the downstreams to which the CMs located in step A are tuned;

E) sending said channel change messages to the CMs located in step A to order said CMs to reconfigure their upstream transmitters to transmit on the upstream created in step C;

F) send switching commands to cause said upstream mapper to change connections to couple optical nodes coupled to said CMs located in step A to a new upstream receiver (receiver #2), and send channel parameter and burst profile data for said new lower throughput upstream channel to receiver #2 to configure said receiver to properly to receive bursts on said new lower throughput channel;

G) when bursts from CMs not having problems communicating upstream but which are coupled to the same optical nodes as the CMs located in step A are scheduled to arrive at said CMTS, sending channel parameter and the burst profile data for the original shared upstream to said receiver #2 to configure said receiver to properly to receive said bursts from said original shared upstream or controlling said upstream mapper to redirect said bursts from said CMs not having problems to the

radio frequency input of said shared upstream receiver to which all initial ranging bursts were directed;

H) doing conventional DOCSIS processing to get said CMs which have been moved to said new lower throughput upstream channel synchronized with said CMTS on the new upstreams to which they have been moved.

16. The process of claim 13 wherein step 19 further comprises the steps of monitoring one or more characteristics of post registration bursts from each cable modem which are indicative of whether said cable modem is having or would be likely to have trouble communicating with said CMTS in future transmissions, and if said characteristics are such as to indicate present or possible future trouble in communicating upstream with said CMTS, creating a new upstream having channel parameters and a burst profile which would be likely to allow each said cable modem which is having trouble communicating upstream to communicate effectively upstream with said CMTS and moving said cable modems which are having problems or which are likely to have future problems communicating with said CMTS to said new upstream.

17. A process carried out in a cable modem termination system (CMTS) comprising the steps:

1) creating DOCSIS downstreams suitable for cable modems coupled to said cable modem termination system via one or more optical nodes of a hybrid fiber coaxial cable system, and creating at least one DOCSIS upstream;

2) implementing a flexible mapping between said downstreams and said optical nodes so as to couple each DOCSIS downstream to one or more of said optical nodes via a downstream mapper;

3) mapping one or more downstreams to a shared upstream receiver in said CMTS, and generating and sending suitable downstream DOCSIS messages to implement said mapping;

4) implementing a flexible mapping of optical nodes to upstream receivers in said CMTS via said upstream mapper;

5) conducting DOCSIS ranging and registration with said cable modems and using information in said ranging and/or registration processes to build a routing table;

6) conducting conventional DOCSIS processing to receive upstream bandwidth requests and send MAP data containing grants of upstream bandwidth to cable modems;

7) carrying out load balance monitoring so as to determine the need to add new upstream receivers to share the traffic load on said shared upstream or to create new upstreams and/or downstreams with channel parameters and burst profiles as needed to meet load balancing considerations; and

8) generating and sending suitable switch control commands to said upstream as needed to change said upstream mapping of optical nodes to receiver inputs and/or change said downstream mapping of transmitters to optical nodes, and generating and sending DOCSIS messages to move cable modems to new upstreams and/or downstreams as needed to meet said load balancing considerations, and generating and sending suitable DOCSIS downstream messages to change mappings of downstreams to a shared upstream as needed to meet said load balancing considerations.

18. The process of claim 17 further comprising the steps of monitoring signal-to-noise-ratio and/or received power during said DOCSIS ranging and, for any cable modem which is not able to successfully complete ranging because of a bad signal-to-noise-ratio and/or inadequate received power, creating a new upstream having channel parameters and a burst profile which is established to allow said cable modem to successfully complete ranging and register as a cable modem with said CMTS, and sending DOCSIS messages to said cable modem to move it to said new upstream and conduct conventional DOCSIS re-initialization if necessary.